



Influence of Bessel Beam Shaping on Nanosecond Pulsed Laser Interaction with Titanium Alloy

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The advancement of pulsed laser material processing techniques is crucial for enhancing material removal efficiency, precision, and quality in industrial applications. Temporal and spatial shaping of the laser beam has been investigated to improve the material removal process [1-2]. Recently, the Bessel beam shape has been considered for high-precision drilling and cutting, in contrast to the conventional Gaussian beam shape and has attracted increasing research interest. Titanium alloys are widely used in aerospace, automotive, biomedical and energy industries due to their high strength-to-weight ratio, excellent fracture toughness, fatigue resistance, biocompatibility, and corrosion resistance. Thus, extensive investigations are essential to understand the mechanisms involved in interaction between pulsed lasers with a Bessel beam shape and titanium alloys.

In this work, a nanosecond pulsed laser with a Bessel beam shape is used to produce deep circular microstructural patterns on the titanium alloy surface by ablation. Laser ablation experiments have been conducted with varying pulse energies, pulse durations and number of pulses. Additionally, numerical simulations are carried out to investigate single and multi-pulse nanosecond laser-material interactions with titanium alloy based on finite element analysis in COMSOL Multiphysics software. The heat conduction governing equation is numerically solved to predict the nanosecond laser ablation process. The shape of the crater formation under nanosecond pulse laser ablation is simulated using a moving mesh approach where Bessel laser beam shape has been considered to match the experimental conditions. The predicted simulation results are compared with experimental results for different laser process parameters. The proposed simulation approach will be useful for producing deep microstructures and optimizing highly efficient drilling applications.

References:

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